CLAIMS

WE CLAIM:

1. A gas discharge laser comprising:

   A) a laser chamber containing a laser gas said laser gas comprising fluorine,

   B) two long-life spaced apart elongated electrode means defining a discharge region for producing at least 12 billion high quality discharges,

   C) a pulse power system for providing electrical pulses at rates in excess of 1000 pulses per second to produce said electric discharges,

   D) a blower system for circulating said laser gas between said two electrodes at a velocity sufficient to remove substantially all debris produced by a discharge prior to a next subsequent discharge when operating at pulse rates in excess of 1000 pulses per second,

   E) a heat exchanger having sufficient capacity to remove heat from said laser gas produced by said blower system and said electric discharges.

2. A laser as in Claim 1 wherein said electrode means comprises two long life elongated electrode elements defining a cathode and an anode, each of said cathode and anode having a long narrow discharge region having a predetermined width chosen to define width of electric discharges between the electrode elements, said anode being comprised of:

   a) a first anode material, defining a first anode erosion rate, located at said long narrow discharge region of said anode said discharge region defining two long edges, and

   b) a second anode material located on at least two sides of said long narrow discharge region of said anode along said two

long edges and adjacent to said long narrow discharge region of said anode,

wherein said first and second anode material are chosen such that the second anode erosion rate is at least 50 percent greater than the first anode erosion rate, and said greater erosion rate of said second anode material prevents any substantial long-term widening of said width of said discharges.

3. A laser as in Claim 2 wherein said first anode material in C36000 brass and said second anode material is C26000 brass.

4. A laser as in Claim 2 wherein said first anode material is a brass containing at least 1 percent lead.

5. A laser as in Claim 2 wherein said first anode material is brass containing at least 3 percent lead.

6. A laser as in Claim 2 wherein said first anode material is chosen from a group of material each of which are know to produce a porous insulating layer when subjected to electric discharges from a cathode in a fluorine containing gas.

7. A laser as in Claim 2 wherein said first anode material is chosen from a group of materials each of which are known to produce a porous fluoride layer when subjected to electric discharges from a cathode in a fluorine containing gas.

8. A laser as in Claim 2 wherein said first anode material comprises a porous insulating layer.

9. A laser as in Claim 8 wherein said porous insulating layer is comprised of a metal fluoride.

10. A laser as in Claim 8 wherein said porous insulating layer is created by exposing said anode to electric discharges in a gas environment wherein gas in said gas environment comprises F_2.

11. A laser as in Claim 8 wherein said porous insulating layer comprises a porous alumina layer.

12. A laser as in Claim 8 wherein said porous alumina layer is an anodized aluminia layer.

13. A laser as in Claim 8 where said porous insulating layer is comprised of particles comprised of an electrical insulator material.

14. A laser as in Claim 13 wherein said insulator material is a ceramic.

15. A laser as in Claim 13 wherein said insulator material is a fluoride.

16. A laser as in Claim 13 wherein said insulator material consists of a ceramic chosen from a group consisting of Al_2O_3, MgF_2 and CaF_2.

17. A laser as in Claim 8 wherein said porous insulating layer is comprised of a large number of holes.

18. A laser as in Claim 16 wherein said large number of holes is in excess of 50,000.

19. A laser as in Claim 17 wherein most of said large number of holes have widths of between 20 microns and 250 microns.

20. A laser as in Claim 1 wherein said anode has a cross section chosen to produce a high electric field over a width, defining the discharge region of said anode, of about 3.5 mm along a centerline of said anode with a sharp decrease in the electric field on both sides of said anode discharge region.

21. A laser as in Claim 1 wherein at least one of said electrode elements define a discharge surface and comprises trenches running longitudinal along two sides of said discharge surface.

22. A laser as in Claim 1 and further comprising a current return structure configured to shape the discharge to a desired shape and further comprising insulating spacers to guide the gas flow through and beyond the discharge region.

23. A laser as in Claim 1 wherein said porous insulating layer is comprised of insulating particles embedded in a metal.

24. A laser as in Claim 23 wherein said metal is a brass.

25. A process for producing an elongated electrode for use in a laser comprising the steps of:

a) fabricating an elongated electrode structure comprised of one or more electrical conducting materials and having a long dimension of at least 50 centimeters and a width of at least 3 centimeters.

b) creating a porous insulating layer on a portion of said elongated electrode, said portion defining a discharge region having a width of at least 3 millimeters.

26. A process as in Claim 25 wherein said one or more electrical conducting materials comprise a lead rich brass having a lead content of greater

than 1 percent, and said step of creating said porous electrical insulating layer comprises operating said electrode in a fluorine containing laser gas to permit a porous insulating layer to build up on the lead rich brass.

27. A process as in Claim 25 wherein said step of creating said porous insulating layer comprises spreading insulating particles on the discharge region of said elongated electrode structure.

28. A process as in Claim 25 wherein said step of creating said porous insulating layer comprises the steps of:

a) mixing insulating particles in a molten metal to produce a discharge section of said elongated electrode said section comprising a filler metal and said insulating particles,

b) operating said elongated electrode in a fluorine containing laser gas environment to permit a portion of said filler metal to sputter away leaving a porous insulating layer covering said discharge region.

29. A process as in Claim 28 wherein said insulating particles have dimensions in the range of about 50 to 150 microns.

30. A process as in Claim 28 wherein said particles have dimensions in the range of about 50 to 150 microns.

31. A process as in Claim 25 wherein said step of creation of porous insulating layer includes the substeps of creating:

a. creating a plurality of nucleation sites on said discharge surface;

b. operating said electrode in a laser containing fluorine gas so as to permit said porous insulating layer to grow on said discharge surface.

32. A laser as in Claim 1 wherein said cathode is comprised of:

a) a first cathode material, defining a first cathode erosion rate, located at said long narrow discharge region of said cathode said region defining two long edges and,

b) a second cathode material, defining a second cathode erosion rate, located on at least two sides of said long narrow discharge region of said cathode along said two long edges and adjacent to said long narrow discharge region of said cathode, wherein said first and second cathode materials are chosen such that the second cathode erosion rate is at least 50 percent greater than the first cathode erosion rate so that during operation of said laser greater erosion rate of said second cathode material prevents any substantial long-term widening of said discharges.

33. A laser as in Claim 32 wherein said first cathode material comprises C26000 brass and said cathode material comprises C36000 brass.

34. A laser as in Claim 32 wherein said first cathode material and said second cathode material each define an average grain size of said first cathode material is less than 70 percent than the average grain size of said second cathode material.

35. A laser as in Claim 34 wherein said first cathode material is annealed to a greater extent than said second cathode material.

36. A laser as in Claim 32 wherein first and second cathode materials are chosen such that first and second cathode materials are chosen such that said second cathode erosion rate is at least four times said first cathode erosion rate.

37. A laser as in Claim 2 wherein first and second anode materials are chosen such that first and second anode materials are chosen such that said second anode erosion rate is at least four times said first anode erosion rate.

38. A laser as in Claim 32 wherein first and second cathode materials are chosen such that first and second cathode materials are chosen such that said second cathode erosion rate is at least ten times said first cathode erosion rate.

39. A laser as in Claim 2 wherein first and second anode materials are chosen such that first and second anode materials are chosen such that said second anode erosion rate is at least ten times said first anode erosion rate.

40. A laser as in Claim 1 wherein said electrode means comprises at least one plasma electrode.

41. A laser as in Claim 39 wherein said at least one plasma electrode comprises a first brass part and a second brass part, said second brass part being separated from said first brass part by an insulator part, a portion of said insulator part defining a plasma discharge surface.

42. A laser as in Claim 40 wherein each of said two plasma electrodes comprises,

a first brass part and a second brass part, said second brass part being separated from said first brass part by an insulator part, a portion of said insulator part defining a plasma discharge surface.

43. A laser as in Claim 1 wherein said electrode means comprises a porous electrode and further comprising a gas supply means for supplying a substantially fluorine-free gas flow through said porous electrode to provide a substantially fluorine free gas layer at a discharge surface of said porous electrode.

44. A laser as in Claim 1 wherein said electrode means comprises at least one electrode, having an elongated portion defining an electrode direction having end parts extending at an angle between 20 and 40 degrees from said electrode direction.

45. A laser as in Claim 1 wherein said electrode means comprises two electrodes, each having end parts extending at an angle between 20 and 40 degrees from said electrode direction.

46. A laser as in Claim 1 wherein said electrode means comprises an anode having a insulator an elongated cathode at ground potential and an anode having a elongated insulator portion and an elongated conductor portion positioned inside said insulator portion wherein said pulse power system is configured to provide high voltage positive electrical pulses to said elongated conductor portion of said anode to produce a corona plasma on a surface of said elongated insulator portion and in electric discharge between said elongated anode and said elongated cathode.

47. A laser as in Claim 1 wherein said elongated electrode means comprises tungsten and said laser further comprises a cold trap for trapping WF_6 gas.

48. A laser as in Claim 1 wherein said electrode means comprises at least one electrode comprising a conducting shim machined as a part of said electrode, said electrode being mounted so that said shim contacts a pre-ionizer tube.

49. A laser as in Claim 1 and further comprising a pre-ionizer tube having a non-circular cross-section.

50. A laser as in Claim 49 wherein said pre-ionizer tube comprises a flat surface and is mounted against another surface so as to avoid any rotational motion of said pre-ioinizer.

51. A laser as in Claim 49 and further comprising a segmented shim for conducting electric current to surface of said pre-ionizer tube.

52. A laser as in Claim 1 and further comprising a pre-ionizer tube having a notch at least one end and having a fixed ground rod with a tab matched to said notch to prevent said tube from rotating.